

AMENDMENTS TO THE SPECIFICATION:

Page 1, please add the following new paragraphs before paragraph [0001]:

[0000.2] CROSS-REFERENCE TO RELATED APPLICATIONS

[0000.4] This application is a 35 USC 371 application of PCT/DE 2004/000846
filed on April 23, 2004.

[0000.6] BACKGROUND OF THE INVENTION

Please replace paragraph [0001] with the following amended paragraph:

[0001] ~~Prior Art~~ **Field of the Invention**

Please replace paragraph [0002] with the following amended paragraph:

[0002] The present invention relates to an **improved** injection nozzle for internal combustion engines~~[[,]] with the characteristics of the preamble to claim 1.~~

Please add the following new paragraph after paragraph [0002]:

[0002.5] Description of the Prior Art

Please replace paragraph [0003] with the following amended paragraph:

[0003] An injection nozzle of ~~this kind~~ **the type with which this invention is concerned** is known, for example, from DE 100 58 153 A1 and has a nozzle body equipped with at least one first injection opening and at least one second injection opening. A first nozzle needle embodied in the form of a hollow needle, which controls the injection of fuel through the at least one first injection opening, is guided in a first needle guide of the nozzle body. A second nozzle needle, which controls the injection of fuel through the at least one second injection opening, is guided coaxially inside the first nozzle needle. In the known injection nozzle, the second nozzle needle is drive-connected to a drive piston that has a control

surface, which is situated in a control chamber and acts in the closing direction when subjected to pressure. The second nozzle needle is equipped with a pressure shoulder, i.e. a cross-sectional area of a second valve seat situated between the second nozzle needle and the nozzle body is smaller than a cross-sectional area of a second needle guide provided to guide the second nozzle needle inside the first nozzle needle. When the first nozzle needle is open, the pressure shoulder of the second nozzle needle is subjected to pressure and this pressure shoulder of the second nozzle needle acts in the opening direction. If the first nozzle needle is open and the second nozzle needle should also be opened, then the pressure in the control chamber can be reduced so that the opening force acting on the pressure shoulder of the second nozzle needle predominates. The cost required for actuating the second nozzle needle here is relatively high.

Page 2, please replace paragraph [0004] with the following amended paragraph:

[0004] ~~Advantages of the Invention~~

SUMMARY AND ADVANTAGES OF THE INVENTION

Please replace paragraph [0005] with the following amended paragraph:

[0005] The injection nozzle according to the present invention[[,]] ~~with the characteristics of the independent claim~~, has the advantage over the prior art that only a single actuator is required in order to trigger both nozzle needles. This simplifies the design of the injection nozzle significantly, thus permitting it to be manufactured at a more reasonable price.

Page 6, please delete paragraph [0014].

Please replace paragraph [0015] with the following amended paragraph:

[0015] ~~Drawings~~ **BRIEF DESCRIPTION OF THE DRAWINGS**

Please replace paragraph [0016] with the following amended paragraph:

[0016] Exemplary embodiments of the injection nozzle according to the present invention are ~~shown in the drawings and will be explained in detail below[[:]]~~ **in conjunction with the drawings in which** components which are the same, similar, or functionally equivalent have been labeled with the same reference numerals[[:]] **and in which:**

Please replace paragraph [0017] with the following amended paragraph:

[0017] ~~Figs. 1-4 show~~ **Fig. 1 shows a** very simplified schematic longitudinal sections through ~~various one~~ embodiment ~~forms~~ of an injection nozzle according to the present invention[[:]] **and**

Please add the following new paragraph after paragraph [0017]:

[0017.5] Figs. 2 - 4, are views similar to Fig. 1 showing further embodiments of the invention.

Please replace paragraph [0018] with the following amended paragraph:

[0018] ~~Description of the Exemplary Embodiments~~

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Page 8, please replace paragraph [0022] with the following amended paragraph:

[0022] The first nozzle needle 8 is embodied in the form of a hollow needle and contains a second needle guide 14 in which a second nozzle needle 15 is supported so that it is able to

execute a stroke motion coaxial to the first nozzle needle 8. The second nozzle needle 15 controls the at least one second nozzle needle 6. To this end, between the nozzle tip 3 and a second needle tip 16 oriented toward the injection openings 5, 6, a second sealing seat 17 is provided, which is situated downstream of the at least one first injection opening 5 and upstream of the at least one second injection opening 6. The sealing seats 10, 17 each extend in annular and linear fashion in the ~~circumference~~ circumferential direction.

Page 15, please replace paragraph [0042] with the following amended paragraph:

[0042] If the fuel injection via the at least one first injection opening 5 is insufficient and a fuel injection should also be executed via the at least one second injection opening 6, then the control piston 38 is moved in the opening direction 52 beyond the stroke distance 53. This first closes the hydraulic connection 48 so that the hydraulic volume contained in the second hydraulic pressure transmission path 47 is hermetically closed. The second hydraulic pressure transmission path 47 is thus activated, which enables it to transmit changes in the pressure acting on the second control surface 37 to the second booster surface 30. This means that when the control piston 38 executes a stroke motion that travels beyond the stroke distance 53, the increase in the volume of the second control chamber 37 produces a pressure drop in the second control chamber 37. The second hydraulic pressure transmission path 47 transmits this pressure drop directly into the second booster chamber 31 so that the second booster surface 30 is also subjected to the reduced pressure. This changes the balance of forces acting on the unit comprised of the second drive piston 28 and second nozzle needle 15

once again so that now, a resulting force acting in the opening direction is produced.

Consequently, the second nozzle needle 15 lifts away from the second sealing seat 17.

Page 17, please replace paragraph [0047] with the following amended paragraph:

[0047] In the injection nozzle 1 according to the present invention, the first hydraulic pressure transmission path 44 is thus permanently active, whereas the present invention permits the second hydraulic pressure transmission path 47 to be activated and deactivated. The second hydraulic transmission path 47 is activated and deactivated as a function of the control piston stroke, thus achieving a stroke-controlled switching between the activated state and the deactivated state for the second hydraulic pressure transmission path 47. ~~For the~~ **The** stroke distance 53 of the control piston 38 at which the second hydraulic pressure transmission path 47 is switched between the activated and deactivated state is suitably set to a predetermined switching value. The predetermined stroke distance 53 is thus also referred to below as the switching value 53. The switching value 53 is suitably selected so that with an opening stroke motion of the control piston 38, before the switching value 53 is reached or at the very latest, when it is reached, the first nozzle needle 8 is opened far enough to be able to execute a normal fuel injection through the at least one first injection opening 5. Only when the control piston 38 is moved beyond the switching value 53 in the opening direction 52 does the second nozzle needle 15 also open in order to execute a fuel injection through the at least one second injection opening 6.

Page 18, please replace paragraph [0049] with the following amended paragraph:

[0049] According to Fig. 2, it is possible for a return spring 55 to prestress the control piston 38 in the direction counter to the opening direction 52. In the variant depicted here, this return spring 55 rests against the nozzle body 2 at one end and at the other end, rests against an actuator piston 56 that is driven directly by an actuator [[57]], in particular piezoelectric actuator 57.

Page 20, please replace paragraph [0054] with the following amended paragraph:

[0054] In the initial position depicted in Fig. 2, the high pressure of the supply line 11 is present in the first hydraulic pressure transmission path 44, yielding a balance of forces acting on the first nozzle needle 8, whose resultant acts in the closing direction. The first pressure shoulder 25 here works in opposition to the closing forces of the first spring 24 and first booster surface 20. The first nozzle needle 8 is thus closed. In addition, the hydraulic connection 48 is open so that the same pressure as in the supply line 11 is present in the second hydraulic pressure transmission path 47. The second hydraulic pressure transmission path 47 is thus deactivated. When the first nozzle needle 8 is closed, the second pressure shoulder 33 is relatively unpressurized. All in all, this yields a balance of forces for the first nozzle needle [[15]] 8 that has a resulting force acting in the closing direction so that the second nozzle needle 15 is also closed.

Please replace paragraph [0055] with the following amended paragraph:

[0055] If a fuel injection should now be executed by means of the at least one first injection opening 5, the actuator 57 triggers the control piston 48 so that it executes a stroke motion in

the opening direction 52 that is smaller than the stroke distance 53, which constitutes the switching value 53 in this instance as well. An opening stroke motion of the control piston 38 increases the volume of the first control chamber ~~[[53]]~~ 35. Since the movement of the control piston 38 occurs at a very high actuation speed, the throttle segment 62 is virtually closed so that the opening stroke motion of the control piston 38 causes a pressure drop in the first control chamber 35. The first control conduit 34 transmits this pressure drop to the first booster chamber 21. This changes the balance of forces acting on the first nozzle needle 8, yielding a resulting force that now acts in the opening direction. As a result, the first nozzle needle 8 lifts away from the first sealing seat 10 and the at least one first injection opening 5 communicates with the nozzle chamber 12. When the first nozzle needle 8 is open, the at least one first injection opening 5 is able to execute the desired injection. With the opening of the first nozzle needle 8, pressure is also exerted against the second pressure shoulder 33, which reduces the resulting closing force acting on the second nozzle needle 15.

Page 24, please replace paragraph [0067] with the following amended paragraph:
[0067] In the embodiment form depicted here, the second hydraulic pressure transmission path 47 includes a coupling piston 67 that is likewise supported so that it is able to execute a stroke motion in the first drive piston 18. At a first end 68 oriented away from the injection openings 5, 6, the coupling piston 67 has a first coupling surface 69 that is situated in the second control chamber 37 and can be subjected to pressure therein. The first coupling surface 69 is thus oriented in the opposite direction from the second control surface ~~[[63]]~~ 43. At a second end 70 oriented away from the first end 68, the coupling piston 67 has a second

coupling surface 71 that is situated in the second booster chamber 31 and oriented in the opposite direction from the first coupling surface 69.

Page 27, please replace paragraph [0076] with the following amended paragraph:

[0076] In the variant according to Fig. [[1]] 4, only a single control chamber 78 is provided; a control surface 79 of the control piston 38 that plunges into the control chamber 78 is contained in this control chamber 78 and can be subjected to pressure therein. The control chamber 78 communicates with the first booster chamber 21 via a control conduit 80. The first hydraulic pressure transmission path 44 consequently extends from the control surface 79 to the first booster surface 20.

Page 30, please replace paragraph [0082] with the following amended paragraph:

[0082] In the initial position depicted in Fig. 4, both of the nozzle needles 8, 15 are closed. The high pressure of the supply line 11 is present in the single control chamber 78. This high pressure is thus also present in the first booster chamber 21. A throttle segment 86, which is embodied for example radially between the piston head 58 of the second drive piston 28 and an associated piston guide 87 of the nozzle body 2 and connects the second compensator chamber [[81]] 61 to the second booster chamber 31 in a throttled fashion, achieves a pressure compensation between the second compensator chamber 61 and the second booster chamber 31, at least during static or quasi-static states. Consequently, the high pressure of the supply line 11 is also present in the second booster chamber 31 in the initial state.

Applicant Friedrich BOECKING
Docket No. R.304749
Preliminary Amdt.

Page 33, please add the following new paragraph after paragraph [0090]:

[0091] The foregoing relates to preferred exemplary embodiments of the invention, it being understood that other variants and embodiments thereof are possible within the spirit and scope of the invention, the latter being defined by the appended claims.

Please delete pages 41, 42 and 43.